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## CHAPTER 5

# Workstation

### INDUSTRY EARLY REVIEW DRAFT V.0.3 — 07/20/1999 7:00 PM–

**NOTE to REVIEWERS:** This is a very early draft version, and no effort has been made to reconcile changes in cross references to other chapters in the guide. Please look for comments such as this in the draft, which encourage your feedback on specific issues.

**Please submit comments using the form on <http://www.pcdesguide.org> or by sending e-mail to [comments@pcdesguide.org](mailto:comments@pcdesguide.org).**

**IMPORTANT:** The requirements defined in this guide provide guidelines for designing PC systems that will result in an optimal user experience with typical Windows-based applications running under either the Microsoft Windows98 “Millennium” or later or Windows2000 Professional or later operating systems. These design guidelines are not the basic system requirements for running any version of Windows operating systems.

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This chapter provides a summary of the key requirements for workstations designed as PC 2001 systems. If there is a conflict with requirements made elsewhere in this guide, the items in this chapter have precedence for workstations. Unless a specific requirement or exception is defined in this chapter, all PC 2001 requirements apply as defined in Chapter [X], “Core System Architecture.”

This chapter describes the requirements that define a workstation optimized to run Windows 2000 Professional and future versions of the Windows 2000 client operating system, and also to support Win32®-based and Win64®-based applications. Workstation PC is a platform for users whose principal computing tasks involve running mission-critical networked applications, engineering or scientific applications, media-authoring tools, or software-development tools.

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Although Windows 2000 is used on stand-alone systems, the PC 2001 system requirements support the more common use of Windows 2000 as a platform for network productivity.

The key design issues for workstations include processor, memory, and bus architecture requirements that support intensive computational activities.

~~It is recognized that~~ OEMs supply Workstation PC systems to customers with specific feature requirements. For example, a customer might want to insert network adapters at the end-user site. However, a Workstation PC system submitted for compliance testing must include all required features.

#### **[4.1] Workstation meets all requirements for Core PC 2001**

Each component indicated as a requirement for a Core PC system is also a requirement for workstations, as defined in Chapter [X], "PC 2001 Core System Architecture."

#### **[4.2] Workstation system components meet minimum performance requirements**

Minimum Workstation PC 2001 system component requirements include the following:

- ?? System board is capable of supporting multiple processors. Although an OEM may ship a workstation configured with a single processor, the system must allow a second processor to be installed.
- ?? 128 MB RAM, minimum (minimum of 64 MB RAM per processor for multiple processor configurations)
- ?? Minimum 256K L2 cache (minimum of 256K L2 cache per processor for multiple processor configurations)

#### **[4.3] Workstation supports multiple processors**

Workstations implementing multiple Intel Architecture processors must meet the following requirements:

- ?? The system must employ those processors symmetrically.
- ?? Each processor must have a separate L2 cache.
- ?? The system must comply with the ACPI ~~1.0b~~ specification (or later) and MultiProcessor Specification (MPS), Version 1.4 or later. ACPI will eventually supersede MPS.
- ?? Systems implementing either an ARC-compliant or ACE-compliant Alpha architecture system meet the requirements for multiprocessor support.

**[4.4] Workstation RAM can be expanded**

If the capability for expanding RAM is implemented, workstation RAM must be capable of being expanded to 1 GB.

**[4.5] Workstation system memory includes ECC memory protection**

The system memory and L2 cache of both 32-bit and 64-bit platforms must be protected with Error Correction Code (ECC) memory protection. All ECC RAM visible to the operating system must be cacheable. The ECC memory subsystem hardware must be able to detect at least a double-bit error in one word and to correct a single-bit error in one word, where “word” means the width in bits of the memory subsystem. A detected error that cannot be corrected must result in a system fault.

**Note to Reviewers: The RAM caching listed here only.**

**[4.6] Workstation includes APIC support**

This requirement does not apply for Alpha architecture workstations.

The workstation must include Advanced Programmable Interrupt Controller (APIC) support that complies with ACPI ~~1.0b~~ 1.0b or later by including the Multiple APIC Description Table (ACPI Section 5.2.8).

Features such as targeted interrupts, broadcast interrupts, and prior-owner interrupts must be supported. Intel Architecture processor implementations can use the Intel APIC component.

**Note to Reviewers: The following is included in the v.0.3 draft, but in future drafts, it will instead be a reference to the related requirement in the Core Architecture chapter.**

If any chip set in the system includes an APIC that uses the APIC bus, then the APIC bus must be clocked and connected to all APICs in the system, including those embedded within the processors.

Chip manufacturers implement I/O APICs in their chip sets, but it is up to the system manufacturer to correctly wire the APIC to the processor. Without an I/O APIC wired in the system, any local APICs are ~~useless~~ rendered useless the possible additional IRQs for device interrupts are not made available to the Windows operating system.

For background information, see *Key Benefits of the I/O APIC* at

~~<http://www.microsoft.com/hwdev/newpc/io-apic.htm>~~  
<http://www.microsoft.com/HWDEV/NewPC/IO-APIC.htm>.

For technical information about how to implement this requirement, see the related chip set guide from your chip set vendor.

**[NEW] PCI bus, bridges, and adapters support DAC command**

**Note to Reviewers: The following section taken from Server Design Guide V2.0, and the associated FAQ (requirement #18) and tuned for workstation**

On 64-bit platforms that provide support for more than 4 GB of system memory, all PCI adapters, including 32-bit PCI adapters, must be able to function properly in the system. In addition, certain classes of adapters, such as those on the primary data path where the majority of network and storage I/O occurs, must also be able to address the full physical address space of the platform. For 32-bit PCI adapters that will be used on the primary data path, this means that the adapter must be able to support the PCI Dual Address Cycle (DAC) command.

Additionally, all 32-bit PCI buses, host bridges, and PCI-to-PCI bridges must also support DAC.

On 64-bit platforms, all PCI bridges on the motherboard must support DAC for inbound access, and DAC-capable devices must not be connected below non-DAC capable bridges, e.g. on adapter cards. New 64-bit adapters should be DAC capable. This DAC requirement does not apply to outbound accesses to PCI devices; however, for systems where DAC is not supported on outbound accesses to PCI devices, the system BIOS must not claim that the bus aperture can be placed above the 4 GB boundary.

There are special considerations that system designers must address when using legacy devices, adapters, and bridges in systems that provide support for more than 4 GB of memory. For information on how Windows 2000 will behave in the case where a non-DAC capable bus is detected on a system that supports more than 4 GB of memory, please see [http://www.microsoft.com/\[placeholder\]](http://www.microsoft.com/[placeholder]). For information on hardware design issues for these systems, please see [http://www.microsoft.com/\[placeholder\]](http://www.microsoft.com/[placeholder]).

**[4.8] Workstation supports 64-bit I/O bus architecture if system includes 64-bit processors**

**Note to Reviewers: The following section taken from Server Design Guide V2.0, and associated FAQ, (requirement #19) reworded for a workstation context.**

64-bit PCI adapters must be able to address any location in the address space supported by the platform.

The workstation must support a 64-bit PCI bus if the workstation has 64-bit processors or has the capability to support greater than 4-GB of physical memory.

**[NEW] 66-MHz and 64-bit PCI buses within a workstation comply with PCI 2.2 ~~and other~~ or later requirements**

**Note to Reviewers: The following section taken from Server Design Guide V2.0, (requirement #36) reworded for clarification**

If either 66 MHz, or 64-bit PCI buses are implemented in a workstation, all devices connected to these buses must meet the requirements defined in PCI 2.2 or later.

**[NEW] For 64-bit platforms, each device and driver meets PC 2001 device ~~and other~~ requirements**

**Note to Reviewers: The following section was extracted from Server Design Guide V2.0, (requirement #54)**

For workstations implementing a 64-bit platform, each device included within the workstation must have 64-bit Windows 2000 compatible drivers

#### **[4.10] Graphics subsystem supports workstation performance demands**

The graphics-intensive application requirements for hardware often exceed the hardware capabilities of the graphics subsystem.

If implementing a workstation supporting user applications that rely on DirectX (in particular, DirectDraw, Direct3D, DirectShow), the graphics subsystem must include hardware acceleration supporting the features, performance, and compatibility requirements of the associated DirectX architecture. For information about requirements for hardware acceleration supported by DirectX, see Chapter [X], "Graphics Adapters."

If implementing a workstation supporting user applications that rely on Windows Imaging Architecture, the graphics subsystem must include hardware supporting the features, performance, and compatibility requirements of Windows Imaging Architecture. For information about requirements for Windows Imaging Architecture, see Chapter [X], "Digital Still Image Peripherals."

**Note to Reviewers: The following requirement will be defined in the Graphics chapter in a future version.**

If implementing an AGP Pro Bus, follow the AGP Pro ~~bus specification,~~  
~~<<specification cited>>~~.1.1 specification (or later), found at  
[http://www.agpforum.org/specs\\_specs.htm](http://www.agpforum.org/specs_specs.htm).

**[4.11] [REDUNDANT] SCSI storage components meet PC 2001 requirements**

**Note to Reviewers: For these requirements, see the Storage or Buses and Interfaces chapters**

**[4.12] Multiple hard drive system meet Workstation PC 2001 performance requirements**

**Note to Reviewers: The intended message here is that for single drive systems, ATA Ultra/66 is OK. For systems attaching multiple drives on an I/O channel SCSI is required.**

When implementing a workstation storage subsystem capable of supporting multiple hard drives, the hard drives must either be allocated independent ATA Ultra/66 (minimum) I/O channels (one channel per physical storage device) or may be grouped and interconnected using SCSI interfaces. This requirement ensures workstation data throughput while allowing less costly ATA interfaces on systems that require only a few drives.

If implementing a redundant array of inexpensive disks (RAID) drive storage subsystem, these arrays can be configured as:

?? RAID 0: Improve performance (multiple spindle access and striping)

?? RAID 1: Data mirroring on parallel drives

?? RAID 5: for data integrity using distributed data and CRCs

If multiple hard drives are implemented, the design must provide a means for the operating system to determine the boot drive. One implementation of boot-drive determination in multiple-drive systems is defined in Section 5.0 of the *Compaq, Intel, Phoenix BIOS Boot Specification, Version 1.01*. The format defined in this specification is what Windows 2000 uses to determine the boot drive when new bootable devices are introduced on the system. The system designer can use an equivalent method for boot-drive determination, but the method must ensure that the boot drive is recognized by the Windows 2000 operating system.

For all related requirements for storage, see Chapter [X], "Storage and Related Peripherals."

**[NEW] Workstation includes ‘new technologies’**

**Note to Reviewers:** This requirement title is a placeholder, to allow the introduction of additional material for the V0.5 release. Please submit your ideas for additional workstation requirements.

**[NEW] Workstation platform meets minimum legacy removal requirements**

**Note to Reviewers:** The following material is a placeholder, to identify the topic; further review is required, we would like your feedback as to suggested legacy items that can be added to this list.

Workstations platforms are not to be configured with the following legacy devices:

- ?? Super I/O
- ?? PS/2-compatible keyboard and mouse
- ?? Serial and parallel ports
- ?? Legacy FDC-based floppy disk drive

## Checklist for Workstation

- [4.1] Workstation meets all requirements for Core PC 2001
- [4.2] Workstation system components meet minimum performance requirements
- [4.3] Workstation supports multiple processors
- [4.4] Workstation RAM can be expanded
- [4.5] Workstation system memory includes ECC memory protection
- [4.6] Workstation includes APIC support
- [NEW] PCI bus, bridges, and adapters support DAC command
- [4.8] Workstation supports 64-bit I/O bus architecture if system includes 64-bit processors
- [NEW] 66-MHz and 64-bit PCI buses within a workstation comply with PCI 2.2 or later requirements
- [NEW] For 64-bit platforms, each device and driver meets PC 2001 device requirements
- [4.10] Graphics subsystem supports workstation performance demands
- [4.11] [REDUNDANT] SCSI storage components meet PC 2001 requirements
- [4.12] Multiple hard drive system meet Workstation PC 2001 performance requirements
- [NEW] Workstation includes ‘new technologies’
- [NEW] Workstation platform meets minimum legacy removal requirements